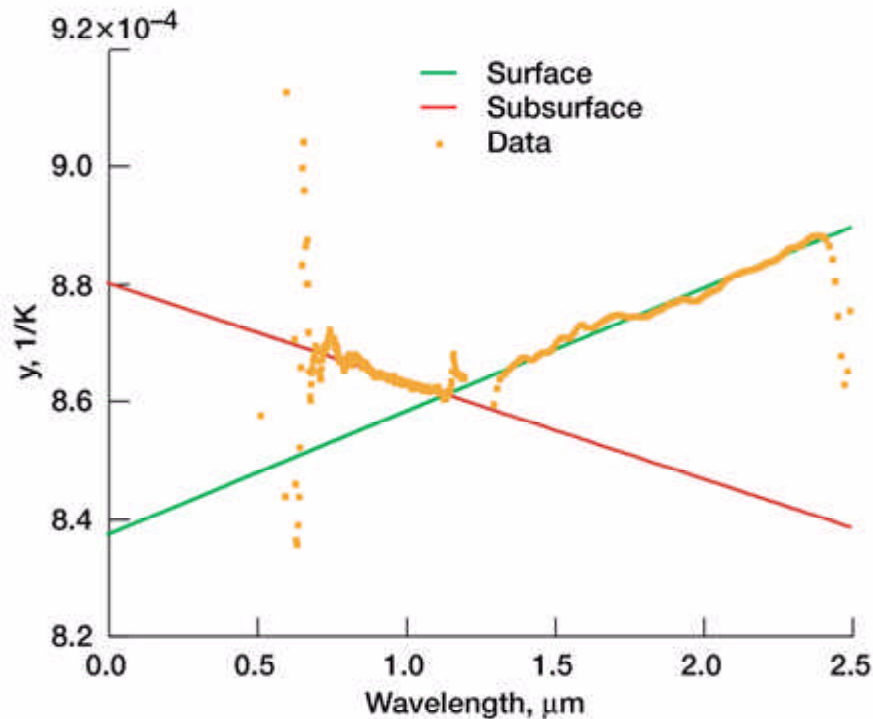


Multiwavelength Pyrometer Developed for Use at Elevated Temperatures in Aerospace Applications

Researchers at the NASA Glenn Research Center have developed a unique multiwavelength pyrometer for aerospace applications. It has been shown to be a useful and versatile instrument for measuring the surface temperatures of ceramic zirconia thermal barrier coatings (TBCs) and alumina, even when their emissivity is unknown. The introduction of fiber optics into the pyrometer has greatly increased the ease of using this instrument. Direct comparison of measurements obtained using the pyrometer and thin-film thermocouples on a sample provided independent verification of pyrometry temperature measurement.

Application of the pyrometer has also included simultaneous surface and bulk temperature measurement in a transparent material (shown in the graph), the measurement of combustion gas temperatures in the flames of an atmospheric burner, the measurement of the temperature distribution appearing on a large surface from the recording of just a single radiation spectrum emitted from this nonuniform temperature surface, and the measurement of some optical properties for special aeronautical materials-such as nanostructured layers.



Surface and subsurface temperatures measured in a transparent glass. $y = 1/T - 1/c_2[\ln(\epsilon t)]$, where T is the absolute temperature in kelvin, λ is the wavelength in meters,

c_2 is the 2nd Plank radiation constant in meters times kelvin, e is the material emissivity, and τ is the transmissivity of the intervening media. At $\lambda = 0$, the value of y is the inverse of the material's temperature.

The multiwavelength pyrometer temperature is obtained from a radiation spectrum recorded over a broad wavelength region by transforming it into a straight line segment(s) (as shown in the graph) in part or all of the spectral region. The intercept of the line segment(s) with the vertical axis at zero wavelength gives the inverse of the temperature. In a two-color pyrometer, the two data points are also amenable to this analysis to determine the unknown temperature. Implicit in a two-color pyrometer is the assumption of wavelength-independent emissivity. Its two (and minimum) pieces of data are sufficient to determine this straight line. However, a multiwavelength pyrometer not only has improved accuracy but also confirms that the wavelength-independent emissivity assumption is valid when a multitude of data points are shown to lie on a simple straight line.

Bibliography

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Glenn contact: Gus Fralick, 216-433-3645, Gustave.C.Fralick@nasa.gov

Author: Dr. Daniel L. Ng

Headquarters program office: OAT

Programs/Projects: HITEMP, HOTPC, Propulsion and Power